Ruminal fatty acid profile and fermentation characteristics in ewes fed sunflower and fish oils

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Introduction

Fish oil (FO) in the diet alters milk fatty acid (FA) composition, enhances milk fat conjugated linoleic acid content (CLA), and also induces milk fat depression (MFD) in lactating cows (Loor *et al.*, 2005). Even though ewes appear less prone to MFD, there is some evidence that supplementing high-concentrate diets with 10 g FO and 20 g sunflower oil (SO)/kg resulted in transient increases of milk fat content (+12%) after 3 d of supplementation, followed by a sustained decrease (up to -27%; Toral *et al.*, unpublished). Under these circumstances, MFD in ewes was not explained by an increase in milk fat *t*10 *c*12-CLA concentration. Changes in milk FA composition were characterized by a severe reduction in 18:0 together with an increase in *trans*-18:1 content. Furthermore, the addition of SO and FO decreased DM intake (-19%) and reduced milk yield (-14%) which may indicate a negative impact of lipid supplements on ruminal fermentation in sheep fed high-concentrate diets. The current experiment was therefore designed to examine the effect of a mixture of SO and FO in the diet on ruminal FA profile and fermentation characteristics in ewes.

Material and methods

Five cannulated Merino ewes (BW: 63 ± 6.0 kg) were fed a total mixed ration (control diet; 35% dehydrated alfalfa hay and 65% concentrate; 41 g DM/kg $BW^{0.75}$) for 11 d (adaptation period). Thereafter, the diet was supplemented with 20 g SO plus 10 g FO/kg DM (SFO treatment) and offered to the sheep for 11 more d. This experimental design was used to avoid carry over effects of oils on ruminal microbiota and biohydrogenation (BH). At the end of the adaptation period (Control) and after 3 (SFO_3) and 10 (SFO_{10}) d on the SFO diet, *in vivo* pH and lactate, ammonia and total VFA concentrations, and *in situ* alfalfa hay DM, NDF and CP disappearance after 24 h incubation (DMD, NDFD, and CPD, respectively) were measured (Toral *et al.*, 2009). Ruminal digesta collected at 0, 3, 6, 12, 18, and 24 h post-feeding was composited to provide single daily samples per ewe and submitted for FA analysis (Shingfield *et al.*, 2003). *In vivo* data taken over time (hours post-feeding) were analysed by repeated measures, and *in situ* measurements and FA composition data by one-way analysis of variance using the MIXED procedure of SAS (Version 9.1).

Results

Ewes consumed all the feed offered throughout the experiment. The SFO supplement had no effect ($P>0.10$) on ruminal fermentation characteristics, DMD or NDFD, but increased ($P<0.01$) marginally CPD (Table 1). However, it resulted in a decrease ($P<0.01$) in the proportion of polyunsaturated FA and a gradual increase ($P<0.01$) in relative concentrations of monounsaturated FA (Table 2), due to progressive accumulation of *trans*-18:1 BH intermediates (*t*11-18:1 accounting for 71% of the increase). Consistent with this, relative proportions of 18:0 were substantially reduced ($P<0.01$) after 10 d on the SFO treatment. SFO

tended (P=0.07) to increase the relative amount of CLA, but no *t*10 *c*12-CLA was detected.

Table 1. Changes in ruminal fermentation characteristics and degradation of alfalfa hay in sheep fed a mixture of 20 g sunflower oil and 10 g fish oil (SFO)/kg DM, on days 0 (Control), 3 (SFO_3) and 10 (SFO_{10}) on diet.

	pH	Lactate, mmol/L	Total VFA, mmol/L	Ammonia, mg/L	DMD, %	NDFD, %	CPD, %
Control	6.3	0.96	113.0	325.9	57.9	30.2	72.7[b]
SFO_3	6.2	0.81	118.6	403.8	61.6	36.0	76.7[a]
SFO_{10}	6.3	0.75	120.7	425.0	61.0	35.7	75.3[a]
s.e.d.	0.07	0.256	8.10	50.88	1.68	2.78	1.08

[a, b] Different superscripts within a column indicate significant differences (P<0.05).

Table 2. Partial FA profile (g/100 g total FA) of ruminal digesta lipids in sheep fed 20 g sunflower oil and 10 g fish oil (SFO)/kg DM, on days 0 (Control), 3 (SFO_3) and 10 (SFO_{10}) on diet.

	Control	SFO_3	SFO_{10}	s.e.d.		Control	SFO_3	SFO_{10}	s.e.d.
18:0	43.6[a]	28.9[b]	10.4[c]	4.68	22:6 *n*-3	<0.1[b]	0.6[a]	0.9[a]	0.16
*t*10-18:1	0.5[c]	1.5[b]	2.1[a]	0.25	*cis*-18:1	6.1	7.7	9.5	1.36
*t*11-18:1	4.1[c]	14.3[b]	28.3[a]	2.38	*trans*-18:1	7.1[c]	26.6[b]	41.3[a]	2.73
*c*9-18:1+*t*14-18:1	5.0	6.3	7.8	1.31	Total CLA	0.4	0.7	0.8	0.15
*c*9 *t*11-CLA	0.1	0.3	0.4	0.15	Saturated FA	69.0[a]	50.3[b]	31.3[c]	4.58
*c*9 *c*12-18:2	11.3[a]	5.5[b]	5.1[b]	1.45	MUFA	14.7[c]	37.8[b]	54.0[a]	3.28
24:0+20:5 *n*-3	0.5[b]	0.6[a]	0.6[a]	0.04	PUFA	15.3[a]	9.6[b]	10.2[b]	2.02

[a, b, c] Different superscripts within a row indicate significant differences (P<0.05).

Conclusions

Relatively high proportions of *trans*-18:1 together with the previously reported decrease in 18:0 and the lack of effects on *in vivo* and *in situ* ruminal parameters, suggests that supplementing ewe diet with 20 g SO plus 10 g FO/kg DM inhibits complete BH of unsaturated FA in the absence of apparent detrimental effects on ruminal fermentation.

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